

## NEGOTIATING THE ESSENTIAL TENSION OF TEACHER COMMUNITIES IN A STATEWIDE MATH TEACHERS' CIRCLE

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*Math Teachers' Circles (MTCs) bring math teachers and university mathematicians together to engage in collaborative mathematical activity. Currently there are over 110 MTCs across 40 states. A key claim is that MTCs are "communities of practice." However, to date there has been no research to substantiate this claim. In this paper, we explore the ways in which participants in an MTC negotiate aspects of community formation.*

Keywords: Teacher Education-Inservice/Professional Development, Teacher Beliefs

Founded in 2006 by the American Institute of Mathematics, Math Teachers' Circles (MTCs; [www.mathteacherscircle.org](http://www.mathteacherscircle.org)) bring K-12 math teachers and research mathematicians together to engage in collaborative mathematical activity. Unlike traditional professional development, which tends to foreground pedagogical practice, MTCs focus on engaging participants in mathematical activity. Notably, the model:

emphasizes developing teachers' understanding of and ability to engage in the practice of mathematics, particularly mathematical problem solving, in the context of significant mathematical content. The core activity of MTCs is regular meetings focused on mathematical exploration, led by mathematicians or co-led by mathematicians and teachers (White, Donaldson, Hodge, & Ruff, 2013, pp. 3-4).

MTCs have expanded rapidly, and currently, there are over 110 MTCs in 40 states. As MTCs have expanded across the country, a small amount of research has begun to explore MTCs as a form of professional development for teachers. One significant finding is that MTCs can increase teachers' mathematical knowledge for teaching (White et al., 2013). This is an important result, as mathematical knowledge for teaching (Ball, Thames, & Phelps, 2008; Hill & Ball, 2009) is associated with effective math teaching (Hill, Rowan, & Ball, 2005). Further, surveys of MTC participants have suggested that teachers who participate in MTCs begin to identify more strongly as mathematicians (Fernandes, Koehler, & Reiter, 2011; White & Donaldson, 2011).

Finally, an often-stated claim is that MTCs are *communities of practice* that support sustained teacher learning. For teachers, communities of practice help to support intellectual renewal and provide a sustained venue for new learning (Grossman, Wineburg, & Woolworth, 2001). However, there is currently no research-based evidence to support the claim that MTCs are—or develop into—communities of practice. This is important because communities are not created by fiat, and not all groups of teachers are communities of practice in the way that the term has been used in the anthropological literature (e.g., Lave & Wenger, 1991; Wenger, 1998).

Given the importance of communities of practice to teacher professional development, it is crucial to understand the ways in which MTCs are—or are not, or develop into—communities of

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practice. In this paper, we explore the ways in which participants in an MTC negotiate aspects of community formation.

### Conceptual Framework

A community of practice is defined by three features: mutual engagement, joint enterprise, and shared repertoire (Wenger, 1998). Mutual engagement refers to the requirement that participants jointly participate in the practice(s) that binds and defines the community. Joint enterprise refers to the purpose of the community. Shared repertoire refers to the objects that are naturalized in the community—those objects that are so natural to members so as to be taken-for-granted, but which may seem foreign or strange to outsiders (Bowker & Star, 1999).

In this paper, we pay particular attention to the negotiation of joint enterprise by focusing on the *essential tension in teacher communities*: the tension between focusing on pedagogical practice on the one hand, and engaging in subject-matter disciplinary practices on the other (Grossman et al., 2001). This is an important consideration with respect to MTCs. Primarily, MTCs are meant to engage participants in mathematical practice. The improvement of pedagogical practices is not a “core” activity (White, et al., 2013). However, Grossman et al. (2001) contend that both foci are essential elements in the joint enterprise of a teacher community:

We contend that these two foci of teacher learning must be “brought into relation” in any successful attempt to create and sustain teacher intellectual community... Teacher community must be equally concerned with student learning and with teacher learning. (p. 952)

Grossman et al. (2001) suggest that the negotiation of the essential tension will go through three ordered stages as a group develops into a community. A “beginning” group demonstrates a lack of agreement around whether the joint enterprise ought to be one focus or the other, and there is often opposition tension between the two foci. An “evolving” group maintains the opposition between the foci, but begins to demonstrate a willingness to allow different people to pursue different foci. Finally, a “mature” community holds the two foci in productive relation, recognizing that “teacher learning and student learning are fundamentally intertwined” (Grossman et al., 2001, p. 988).

### Research Questions

On the one hand, pedagogical practice is officially backgrounded in MTCs so as to maintain a focus on engagement in disciplinary practice. On the other hand, “for a group of teachers to emerge as a professional community, the well-being of students must be central” (Grossman et al., 2001, p. 951). This makes us wonder, even if the stated goal of an MTC is to engage participants in mathematical activity, *what actually happens when a group of math teachers gets together to do mathematics?* Do teachers simply engage in mathematical activity? Do they focus on pedagogy? Or some combination? Our study is the first to employ anthropological methods to answer anthropological questions about math teachers’ circles—in particular, just *what is* the joint enterprise, as it is negotiated by participants? Our research questions are:

1. In what ways, if at all, are the two foci of the essential tension—mathematical activity and pedagogical practice— manifested in MTCs?
2. When pedagogical practice is invoked, how is it treated by participants?

### Materials and Methods of Analysis

Our data come from the initial gatherings of a newly-inaugurated statewide MTC. The gatherings include two after-school gatherings from each of five state-wide locations and a 3-day “summer retreat.” These were the first gatherings for the statewide MTC, although two locations had previously hosted MTC gatherings.

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Local gatherings were facilitated by “lead teams” composed of 3-5 local teachers and university mathematicians. These lead teams attended a group training session facilitated by the American Institute of Mathematics, the organization that created and currently disseminates the MTC model. The lead teams designed and conducted their gatherings independently of each other. The summer retreat was organized and facilitated by the coordinators of the statewide MTC, four of whom are also authors of this paper (Peck, Erickson, Roscoe, and Wu).

Gatherings were organized around “activities”—mathematical problems that participants worked on groups of 3-6 people, followed by large group discussions of the problem. There was 1 activity in each of the 10 local gatherings, and 9 activities in the summer retreat. In all, the data encompass 11 gatherings and 19 activities. Across all sites, there were 177 participants: approximately 80% were practicing teachers (20% elementary, 30% middle school, 30% high school), approximately 10% were post-secondary mathematics faculty, and approximately 10% were pre-service teachers (these percentages are approximate because there are some participants for whom we do not have demographic data).

Communities develop via engagement in joint activity. Participants interact with each other and with artifacts, and through this interaction norms of engagement, joint practices, and a shared repertoire emerges; a community develops and people become part of it (Bowker & Star, 1999; Dean, 2005; Lave & Wenger, 1991). Because community development occurs in interaction, we used video and audio recorders to capture the naturally-occurring interactions of participants as they engaged in activity during the gatherings. For each of the 19 activities, we have video and audio recordings of 2-6 problem-solving groups. Additional data include:

- Participants’ notebooks from the summer retreat. Participants used these notebooks for jottings and work space during the retreat. They also used the notebooks to provide written responses to a series of reflection prompts at the end of the retreat.
- Interviews with 10 participants from the summer retreat. This represents a selective sample of all participants. We invited all participants to be interviewed. From the set who agreed to be interviewed, we chose interviewees selectively in order to achieve a diverse sample with respect to gender self-identification, level taught (elementary, middle, high), and region of the state.

Our initial analysis focused on the recordings of MTC activities. We used a cyclical data analysis method, which relied on both inductive and deductive approaches (Miles, Huberman, & Saldaña, 2014). First, we developed a list of deductive codes based on our conceptual framework. We then engaged in the following process for each activity. Members of the research team each watched/listened to a different group engaging in the same activity. The team member created a content log (Maxwell, 2013) of the recording and coded the log according to the codebook, allowing new codes to emerge from the data. We then met to discuss our observations and coding. We refined our codebook and then used the refined codebook to code the next activity. We proceeded in this fashion, with inductive codes emerging from the data and subsequently undergoing refinement, for all 19 activities.

We used these coded content logs to identify key segments in which participants negotiated the two foci of the essential tension (mathematical activity and pedagogical practice). We transcribed these key segments and analyzed them using multi-modal interaction analysis (Erickson, 1992; Goodwin & Heritage, 1990; Streeck, 2009).

We employed a similar procedure to analyze the participants’ notebooks and interviews.

### Findings

We present our findings organized around our two research questions.

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### **RQ 1: In What Ways, if at all, Are the Two Poles of the Essential Tension Manifested in MTCs?**

Perhaps unsurprisingly, we found that the majority of activity in MTCs involved engaging in disciplinary (mathematical) practices. Pedagogical concerns occupied less than 5% of the “official” activity. We gloss an activity as “official” if it was introduced by the facilitators as the focal activity of the group.

Pedagogical concerns were sometimes explicitly backgrounded by facilitators. For example, in the introduction to the one of the initial spring gatherings, a facilitator explained the goals for the gathering:

You shouldn't feel like there's any expectation to be walking away this evening with anything other than a good feeling, alright? We're not trying to prove anything, this is just for us. We're not trying to say, “and now, fourth-grade math achievement will go up because-” ((laughter)). That has nothing to do with it. You see, we're just- what we're trying to do is just, be a group that likes mathematics.

In this turn, the facilitator invokes both pedagogical concerns (“fourth-grade math achievement”) and disciplinary activity (“be a group that likes mathematics”). The turn is designed such that the two foci are put into opposition with each other. This can be seen in the use of the adverbs “not” and “just” to modify the verb “trying” in the second half of the turn (“*not* trying,” and “*just* trying”). In particular, the use of the word “not” in “we're not trying to say” negates the pedagogical focus. This is reinforced with the exclusionary “just” in reference to mathematical activity.

This finding—that the primary activity of an MTC is mathematical, not pedagogical, activity—is not surprising, given that engagement in mathematical activity is the explicit purpose of MTCs. Furthermore, the finding that the two foci were treated oppositionally is also not surprising due to the “beginning” nature of these teacher groups.

However, we also found that pedagogical concerns were invoked in multiple, interesting—and sometimes surprising—ways during MTCs.

Pedagogy was rarely the official topic of activity. Most commonly, if pedagogy was the official activity of an MTC gathering, it happened in the final phase of the gathering. This phase was framed as a “reflection” time, and pedagogy was a topic for reflection. For example, at the end of the 3-day summer retreat, the group met all together, and reflected on what it meant to *do* mathematics, based on their experience in the summer retreat. After the group generated a list of attributes associated with doing mathematics, the facilitator (Peck) referenced the list and said:

So if we think about all this stuff that doing mathematics *is*, um, take a moment and write just a couple ideas about how you might incorporate some of this into your classroom.

Both the design of this turn, and the subsequent uptake by participants provide evidence that pedagogy has become the official activity. By employing the imperative mood (*take* a moment and *write* just a couple of ideas...), and applying it to pedagogical concerns (...about how you might incorporate some of this into your classrooms), the facilitator signals that the official activity is now related to pedagogy. Participants' uptake confirms this. After the facilitator's turn ended, participants began writing and there is silence on the video and audio recordings. Analysis of participants' notebooks confirms that each response involves pedagogy.

Notice also how this turn brings pedagogy into a productive relationship with mathematical activity. Rather than treating pedagogy as separate from the mathematical activity of the retreat, the facilitator, through the use of the word “incorporate,” suggests that the mathematical activity of the retreat can productively be brought to bear on classroom pedagogy.

More commonly, pedagogy came up informally in relation to the concurrent mathematical activity. As participants engaged in mathematical activity, they often related the activity to pedagogy. For example, the strip of dialog in Table 1 occurred while participants were exploring the question, “can any number be written using only powers of 2?” The three participants, Amy (5-6<sup>th</sup> grade teacher), Diane (3<sup>rd</sup> grade teacher), and Patty (7-12<sup>th</sup> grade math teacher) discuss the mathematical question in turns 1-17. In turns 18-20, they transition to a pedagogical discussion related to the mathematical activity, which they continue for the remainder of the strip.

**Table 1: Doing Mathematics and Talking Pedagogy**

Turn	Speaker	Talk <sup>1</sup>
1	Amy:	I think, I mean-
2	Diane:	Well we have to be able to because how else- That’s how binary works.
3	Amy:	How else could we-
4	Diane:	They have to-
5	Patty:	Make every number?
6	Diane:	Yeah, binary’s gonna work every time.
7	Patty:	mmm-hmm  ((Amy looks at notebook, where she has written a list of powers of 2.))
8	Amy:	How do you get 127?
9	Diane:	((points to notebook)) There’s your two, 16 - ((moves finger along notebook, where Amy has written successive powers of 2)) That’s gonna be... one hundred... [twenty seven!
10	Amy:	[twenty seven! Okay...  ((Talk continues in this fashion, for turns 11-17, with Amy suggesting an number, and Diane showing how to make the number)).
18	Amy:	Two:::: f::::- ((smiling))
19	Diane:	You little pain in the butt! ((laughing))
20	Amy:	Hmmm... I’m trying to think like a f-
21	Diane:	Trying to think like a sixth-grader?
22	Amy:	Yes!
23	Diane:	They are difficult little critters, but they’re adorable!
24	Amy:	“well what if you want to do this? What if you want to do this?”
25	Diane:	“So tell me how. What’s the pattern you’re seeing?”
26	Patty:	So what grade do you start doing these problems?
27	Amy:	Binary?
28	Patty:	No-
29	Diane:	Exponents!
30	Amy:	[Oh exponents
31	Patty:	[Yeah, just- just exponents?
32	Amy:	Fifth- fifth grade.

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33	Patty:	Well, we talk about squaring (crosstalk) not- not square roots-
34	Diane:	Just squared?
35	Patty:	Just squared. So I [sh-
36	Amy:	[I don't even talk about square roots, until-
37	Patty:	So I show the kids that notation ((draws a "2" in the air)), and I talk to them about how if it's 54 square units, I show them how you can write 54 units squared ((draws "2" in the air)) [with a-.
38	Amy:	[yeah
39	Patty:	with a- with an exponent two... so what grade do you start talking about, "what does that exponent MEAN?" ((draws 2 in the air)) and-
40	Amy:	I do fifth and sixth grade, and in fifth grade I introduce it to them-
41	Patty:	Okay.

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<sup>1</sup> In general, talk is transcribed using standard punctuation, so that a comma denotes a short pause, a period denotes a longer pause after a falling intonation, and a question mark denotes a pause after a rising intonation. Ellipses ... denote a long pause. Underline denotes vocal emphasis, co:::lons denote a drawn-out sound, and a hyphen- denotes a restart. Vertically-aligned open brackets [denote overlapping speech. ((Double parentheses)) denote non-vocal action.

Because participants often invoked pedagogy even when it was not the "official" topic, we found that participants were engaged in pedagogical conversations or activity approximately 15% of the time—3 times more than that which was accounted for in the official activity.

## **RQ 2: When Pedagogical Practice Is Invoked, How Is It Treated by Participants?**

We found that pedagogical practice was treated as a normative topic of discussion in MTCs. The strip in Table 1 is representative of this. Notice the framing of the turns where pedagogy is first evoked, and the response to these turns:

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20	Amy:	Hmmm... I'm trying to think like a f-
21	Diane:	Trying to think like a sixth-grader?
22	Amy:	Yes!
23	Diane:	They are difficult little critters, but they're adorable!
24	Amy:	"well what if you want to do this? What if you want to do this?"
25	Diane:	"So tell me how. What's the pattern you're seeing?"
26	Patty:	So what grade do you start doing these problems?
27	Amy:	Binary?
28	Patty:	No-
29	Diane:	Exponents!
30	Amy:	[Oh exponents

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In particular, notice the absence of an account for why pedagogy is being introduced. Neither Amy nor Patty provides a rationale for why they are introducing pedagogy, and subsequent turns do not hold them to account for such an introduction. Together the design of turns 20-30 can be taken as evidence that for these participants, pedagogy is normative topic of discussion (consider how these turns would be designed differently in a situation where pedagogy was not normative, say at an adult-

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league softball game). This finding is somewhat surprising, considering the “official” framing of MTCs as primarily focused on engaging in disciplinary practice.

Even though pedagogy was a normative topic, the way that it interacted with disciplinary practices varied. In some cases, these two foci were treated oppositionally, as would be expected in a “beginning” group like the ones that we studied. The first facilitator quote given above is one example of this. A second example comes from the reflections of participants in the summer retreat, one of whom wrote,

Some of the activities were good, but others were not helpful. I guess I was looking for more options to take back to my classroom.

Using the word “but,” the participant contrasts “good” activities with those that were “not helpful.” She goes on to identify “helpful” activities as those that could be used in the classroom. This comes even after the participant discussed how much she had learned about doing mathematics from the activities. This suggests that, for this participant, “engaging in disciplinary activity” and “improving pedagogical practice” are two *separate* foci.

However, we also found multiple times where the two foci were held in “productive relation,” which would be evidence of a more mature community. The strip of talk in Table 1 is one example of this, where the content of the activity spurred a conversation about pedagogy related to that content.

We also see evidence for the “productive relation” in participants’ reflections. For example, a different participant reflected:

Working together to solve problems reminds me how important and fun it is, and I need to do that as much as possible in my class!

Here the participant uses a different conjunction: “and” instead of “but.” In doing so, she brings disciplinary activity (“working together to solve problems”) into a productive relation with pedagogy (“I need to do that... in my class”).

### Conclusion and Significance

Math Teachers’ Circles have exploded in popularity since their introduction in 2006. A key claim is that MTCs constitute *communities of practice*. However, this claim has not been subjected to analytical scrutiny. In this paper, we take a step towards such scrutiny by employing anthropological methods to analyze the ways that participants in MTCs negotiate their joint enterprise.

We found evidence that both disciplinary practice *and* pedagogical practice are part of the joint enterprise. This is a surprising finding because the groups are “officially” framed around disciplinary practice only, and are represented as such in the published literature (e.g., the excerpt from White et al, 2013, in the introduction). This supports Grossman et al.’s contention that teacher communities must include a focus on pedagogical practice.

We also found that, in negotiating the joint enterprise, MTC groups display hallmarks of both “beginning groups” and “mature communities.” This complicates the claim that all MTCs are communities of practice: our findings suggest that a beginning MTC, at least, may not be a mature community of practice. Participants are still negotiating the essential tension, and some participants struggle to hold the two foci in productive relation.

However, what is perhaps our most striking finding is that, most often, when pedagogy was invoked, it was treated as normative by participants. Most of the time, when the “essential tension” manifested itself, there was no *tension* at all. This finding complicates the model of Grossman et al. (2001) in which communities must go through ordered stages of oppositional tension between mathematical activity and pedagogical practice, before they can hold the two in productive relation. This finding should be explored and elaborated in future research.

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